

1    **ABSTRACT**

2       An optical apparatus comprises an optical element having at least one set of  
3       diffractive elements and multiple channel optical waveguides. Diffractive elements of  
4       each set are distributed among diffractive element subsets corresponding to each of the  
5       multiple channel waveguides. Each diffractive element set routes, between a  
6       corresponding pair of optical ports, those corresponding portions of an optical signal  
7       propagating within the optical element that are received by multiple channel waveguides  
8       and back-diffracted within the receiving channel waveguides by corresponding  
9       diffractive element subsets. The channel optical waveguides are arranged so that  
10      optical signals propagate through regions of the optical element between the ports and  
11      the first ends of the channel waveguides. Relative spatial arrangement of the first ends  
12      of the channel waveguides and corresponding relative phase shifts imparted in the  
13      channel waveguides define at least in part a relative spatial arrangement of the  
14      corresponding pair of optical ports.

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